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SCIENTIFIC AND METHODOLOGICAL ASPECTS OF THE PROPOSAL BY BRAZIL

Progress report on the review of the scientific and methodological aspects of the proposal by Brazil

Note by the secretariat

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I. INTRODUCTION

A. Mandate

1. The Conference of the Parties (COP), at its third session, decided that the proposal presented by Brazil in document FCCC/AGBM/1997/MISC.1/Add.3 should be referred to the Subsidiary Body for Scientific and Technological Advice (SBSTA) for its advice regarding the methodological and scientific aspects. It authorized the SBSTA to seek inputs, as appropriate, from its roster of experts and from the Intergovernmental Panel on Climate Change (IPCC), and requested it to make its advice available to the COP at its fourth session (FCCC/CP/1997/7, para. 69).

2. The SBSTA, at its eighth session, noted that the portion of that proposal referring to a clean development fund had now been overtaken by decisions taken by the COP at its third session, in particular, the provision for a clean development mechanism as defined in Article 12 of the Kyoto Protocol, that Protocol's Annex B and decision 1/CP.3 on the adoption of the Kyoto Protocol. The SBSTA recognized that there were a number of methodological and scientific issues raised by the remainder of the proposal and that these were still being investigated by scientists in several countries. The SBSTA welcomed the offer by the delegation of Brazil to host a workshop to further the understanding of the methodological and scientific aspects of the remainder of the proposal (FCCC/SBSTA/1998/6, para. 51).

3. The SBSTA, at its ninth session, noted the information provided by Brazil on recent scientific activities and on the workshop to be organized regarding the proposal presented by Brazil in document FCCC/AGBM/1997/MISC.1/Add.3. The SBSTA also noted the potential contribution of other relevant analyses to increase understanding of the methodological and scientific aspects of this proposal. The SBSTA invited the delegation of Brazil to inform the SBSTA at its tenth session, of the results of its workshop and to provide it with other relevant information (FCCC/SBSTA/1998/9, para. 29).

4. The SBSTA, at its eleventh session, took note of the information provided by the delegation of Brazil, including a revised version of the methodology originally proposed in document FCCC/AGBM/1997/MISC.1/Add.3. The SBSTA commended Brazil for its work on this subject. The SBSTA also noted that the IPCC Third Assessment Report is likely to contain the best available information related to the values of the parameters and other material relevant to the assessment of the proposal. It also noted the need for further scientific analyses.

5. At the same session, the SBSTA further requested the secretariat to coordinate a review of this proposal by experts selected from the roster of experts, to be completed in time for its fourteenth session. It also requested the secretariat to make the information provided by the experts available on its web site.

6. Furthermore, the SBSTA invited the delegation of Brazil and other Parties to send to the secretariat information on the scientific and methodological aspects of, and related information on, the Brazilian proposal and requested the secretariat to make this information available on its web site for use by experts (FCCC/SBSTA/1999/14, para. 63).

B. Scope of the note

7. This document contains background information on the proposal by Brazil and its past consideration in section II, the conclusions of the expert meeting on its review in section III and a discussion on possible next steps in section IV.

C. Possible action by the SBSTA

8. The SBSTA may wish to take note of information provided in this document and to provide guidance on what additional aspects of the proposal by Brazil need further consideration and how these issues should be addressed.

II. BACKGROUND

A. The proposal by Brazil

9. During the negotiations of the Kyoto Protocol in 1997, the delegation of Brazil made a proposal for distributing the burden of emission reductions among Parties included in Annex I to the Convention (Annex I Parties) (FCCC/AGBM/1997/MISC.1/Add.3):

(a) The proposal suggested that reductions towards an overall emission ceiling for all Annex I Parties (30 per cent below 1990 levels by the year 2020) were to be shared among individual Annex I Parties proportional to their relative share of responsibility for climate change;

(b) The original paper presented by Brazil in 1997 proposed an approach for estimating the relative share of responsibility for climate change of different Annex I Parties, based on their contribution to the increase of global-average surface temperature over a certain period of time;

(c) The proposal suggested using an agreed simple climate model for estimating the temperature increase resulting from emissions of different countries. As an illustration, the original proposal in 1997 included a calculation using a "policy-maker model" for such estimation;

(d) The proposal also contained a penalty mechanism called the "clean development fund". It was to be supported by requiring non-complying Annex I Parties to pay a financial penalty for every ton of carbon above their target. The revenue was to be used to fund projects for Parties not included in Annex I to the Convention (non-Annex I Parties).

B. Past considerations of the proposal

10. The delegation of Brazil organized an informal meeting on the evaluation of the Brazilian proposal during the fourth session of the COP in November 1998, for which it made available an update of the calculation method for estimating the temperature increase from emissions. Furthermore, the delegation of Brazil organized an expert meeting on the Brazilian proposal, "Scientific aspects and data availability", held from 19 to 20 May 1999 in Cachoeira Paulista, Brazil.

11. At the tenth session of the SBSTA in November 1999, the delegation of Brazil made available a further update of the calculation method for estimating the temperature increase from emissions. The latest version, dated January 2000, is available from the Ministry for Science and Technology, Brazil, on its web site.[1]

III. PREPARATION OF THE REVIEW

12. During the thirteenth session of the SBSTA in September 2000, the secretariat distributed a letter to all Parties asking for further nominations to the roster of experts, since only a limited number of experts had been nominated for the review of the proposal by Brazil. Subsequently, only a few additional nominations were received.

13. At its eleventh session, the SBSTA had invited the delegation of Brazil and other Parties to send to the secretariat information on the scientific and methodological aspects of, and related information on, the Brazilian proposal and had requested the secretariat to make this information available on its web site for use by experts. No such submissions were received.

14. To initiate the review of the proposal, the secretariat organized an expert meeting from 28 to 30 May in Bonn, Germany. Fourteen experts from the scientific community attended. The experts were selected in consultation with the Chairman of the SBSTA and the Chairman of the IPCC. The meeting was chaired by Mr. Bert Metz of the Netherlands. The list of participants is contained in annex I to this document.

15. Relevant information on the proposal is available from the UNFCCC web site, including the proposal itself, the update of the calculation method by Brazil, detailed information on the expert meeting and information provided by the experts.[2]

IV. CONCLUSIONS OF THE EXPERT MEETING

A. General

16. The primary focus of the expert meeting was to identify issues relating to the scientific and methodological aspects of the Brazilian proposal, including those that need further consideration and areas of future work.

17. Several experts noted that there are other approaches to estimate the relative share of responsibility for climate change. The scientific and methodological aspects of those other approaches were not discussed at the expert meeting.

18. The expert meeting did not undertake a review of other aspects of the original paper as referred to in paragraph 9 (a) and (d) above and it did not undertake a discussion of policy issues. The participants noted that the way in which calculations are to be applied could influence future scientific and methodological improvements to calculations. For example, the current model by Brazil does not include aerosols and tropospheric ozone as these were not under discussion at the time the Kyoto Protocol was being negotiated. If policy makers decide to include aerosols and

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[1] http://www.mct.gov.br/clima. Hard copies may be obtained from: Ministerio da Ciência e Tecnologia, Gabinete do Ministro, Esplanada dos Ministérios, Bloco E - 3 Andar - Sala 398, 70067-900 Brasília, Brazil.

[2] http://www.unfccc.int/issues/brazil.html

tropospheric ozone - and their precursors - in a basket of pollutants to be mitigated in the future, the calculation would need to be revised accordingly.

19. It was noted that future considerations of the proposal would be enhanced if the Government of Brazil were to make available a written report on the current version.

B. Methods to calculate the relative responsibility for climate change

20. To calculate the relative responsibility for climate change one needs to consider the cause-effect chain which leads from emissions of greenhouse gases to changes in climate: emissions of greenhouse gases, precursors and aerosols change the concentration of these and other gases in the atmosphere. Changed concentrations influence the radiative forcing.[3] Changed radiative forcing influences the global-average surface temperature with a certain time delay. The absolute change in temperature, as well as the rate of its change, influences the sea level and other parameters such as precipitation and related damages.

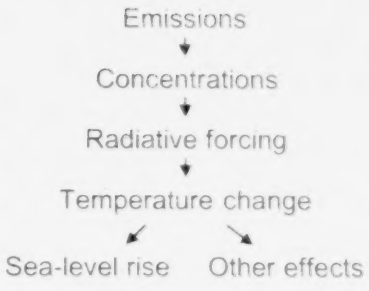

Figure 1: Cause-effect chain used to estimate relative responsibility for climate change

21. The "policy-maker" model of 1997 assumed that the temperature increase is proportional to the time integral of the radiative forcing. This assumption is only valid for very short periods and this aspect of the model was later corrected. In addition, it was modified to account for non-linearities in the carbon cycle and in the relation between concentrations and radiative forcing. As a consequence of the inclusion of non-linearities, the latest version attributes climate change to different sources using a differential or marginal approach.

22. Further, the rates of temperature change and mean sea-level rise were added as global variables that could be considered as a basis for attribution in addition to the temperature increase.

1. General conclusions on the method

Choice of the index to be used as a measure of the effect of emissions on climate change

23. The experts concluded that indices along the cause-effect chain, such as current emissions, cumulative historical emissions, concentration levels, radiative forcing, global mean surface temperature increase, rate of temperature change and sea-level rise can be calculated and attributed to different sources of emissions. Different indices would lead to different relative attributions.

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[3] Radiative forcing is a measure of the influence a factor, such as increased concentrations, has in altering the balance of incoming and outgoing energy in the earth-atmosphere system.

24. The attribution estimates derived from an index further down the cause-effect chain from emissions to climate change would in most cases be more uncertain because of the cumulative uncertainties, but some individual uncertainties (e.g., in very early emissions) are damped as one progresses down the cause-effect chain.

25. Indices of the cause-effect chain from concentrations onwards, taken at a particular point in time, do not take into account "unrealized warming", that is, the effect of the emissions up to the particular point in time on climate changes thereafter. This concern can be addressed by evaluating these indices for any time after that point, assuming emissions had stopped at that particular point in time.

26. Regarding future work, it was recommended that additional analyses be undertaken to calculate the relative contribution to climate change of different sources according to different indices, and to examine the sensitivity of the attribution estimates to different indices at different times. For these comparisons, it would be helpful to define common input data (i.e., historical emissions).

Non-linearities

27. The experts noted that emissions of greenhouse gases at one point in time have a different effect on concentrations, radiative forcing and temperature than if the same quantity is emitted at another point in time, due to the changing composition of the atmosphere and changing atmospheric processes. If this non-linear effect is taken into account, the attribution of "early" and "late" emitters will be different. This can be handled mathematically by working on the margin, derivative or tangent. Using this approach, the individual attribution estimates may not add up to the estimate calculated from all emissions. This effect can be compensated by normalizing the individual contributions to the total.

Displaying of results

28. The experts concluded that it would be useful to put the attribution estimates in the context of other socio-economic indicators, such as population or economic output.

Use of climate models

29. The experts concluded that several existing simple climate models could be used in the calculation of the attribution. Such models simulate the real concentration and temperature records. Validation of the models used for the attribution through the simulation of the observed record of atmospheric composition and climate change is seen as essential.

30. Regarding future work, it was recommended that several existing simple climate models be used to prepare attribution calculations with harmonized input parameters in an open and transparent process. A condition for participating in such a process would be that the code of the participating models is made available.

Uncertainty of the attribution calculation

31. The experts noted that the overall uncertainty is a function of the individual uncertainties of each step of the cause-effect chain.

32. Regarding future work, it was recommended that the overall uncertainty of the attribution calculations should be estimated.

Different scenarios

33. The experts noted that the use of different future emissions scenarios would influence the results of the attribution estimates for points in time in the future.

34. Regarding future work, it was recommended that the emission scenarios contained in the IPCC Special Report on Emission Scenarios be used to examine the sensitivity of the attribution estimates to different scenarios.

2. Emissions to concentrations

Data sources for historic emissions

35. The experts noted that it is possible to calculate the attribution of emissions from any year onwards, given data availability and data accuracy. The original proposal by Brazil included calculations for starting years 1840 and 1990.

36. The experts concluded that data on all greenhouse gases from the year 1990 onwards are sufficiently reliable and detailed to make attribution estimates. Before 1990 there are much larger uncertainties. Land-use change and forestry data in particular need major improvement, as does the inventory for aerosols other than sulfate. All greenhouse gases included in Annex A to the Kyoto Protocol should be included in the analysis. For the purpose of model validation and acceptance by the community, the full range of greenhouse gases and aerosols that contribute significantly to climate change need to be included. For points in time in the future, this full range needs to be included to make accurate attribution estimates.

37. Regarding future work, it was recommended that analyses should be undertaken to compare attribution estimates based on different starting dates for a variety of countries for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), and to examine the sensitivity of the attribution estimates to the uncertainty range of the historic data.

Carbon dioxide (CO_2)

38. It was concluded that all sources of CO_2 be used in the analyses and that a number of carbon cycle models be used to capture the full possible range and the feedback on the cycle due to temperature change and CO_2 fertilization effects.

39. Regarding future work, it was recommended that the impact of climate feedbacks on the carbon cycle in the future under different scenarios contained in the IPCC Special Report on Emission Scenarios be examined.

Methane (CH_4)

40. The experts noted that the levels of hydroxyl radicals (OH) and the indirect effect of methane on tropospheric ozone are significant for the total radiative forcing caused by methane emissions. Historic levels of OH are not available, so that this effect can only be represented by a factor in making the calculations (see also paragraph 43). Similarly, the indirect effect on

tropospheric ozone can also be represented as a factor in the calculations. These factors have an uncertainty range, which decreases from the past to the present and which influences the total uncertainty of the attribution results. The experts noted that the additional tropospheric ozone due to methane emissions is only a fraction of the total greenhouse effect caused by tropospheric ozone.

Aerosols

41. The experts noted that some historic data on precursors of sulphate aerosols (i.e., SO_2) from fossil fuels are available, but the uncertainties are not characterized. Historic data on non-sulphate aerosols from fossil fuels and aerosols from biomass are not available. The inclusion of aerosols in the attribution calculation would change the relative contribution of sources. Aerosols are not covered by the Kyoto Protocol. Descriptions of the atmospheric processes induced by aerosols are available. Their inclusion would allow the total change in concentration and temperature calculated to be validated against historic records, a useful feature even if aerosols are not included in the attribution calculations.

Carbon monoxide (CO) and oxides of nitrogen (NO_x)

42. The experts noted that CO and NO_x have an indirect effect on temperature through their effect on OH levels, which subsequently influence methane concentrations and on tropospheric ozone. However, CO and NO_x are not covered by the Kyoto Protocol. Inclusion of the effects of these gases in the attribution would change the relative contribution of sources. Descriptions of the atmospheric processes induced by CO and NO_x are available. Their inclusion would allow the total change in concentration and temperature calculated to be validated against historic records, a useful feature even if CO and NO_x are not included in the attribution calculations.

Hydroxyl radicals (OH)

43. The experts noted that the levels of OH have an effect on temperature by altering lifetimes of CH_4 and hydrofluorocarbons (HFCs). The level of OH in the atmosphere is a function of emissions of CH_4, NO_x, CO and volatile organic compounds (VOCs). Since national emissions data of NO_x, CO and VOCs for years prior to 1990 are not available, only the effect on methane can be approximated for attribution calculations prior to 1990 (see paragraph 40 above). For attribution post 1990 it would be possible to use information on emissions of CH_4, NO_x, CO, VOCs and OH concentrations.

Tropospheric ozone

44. The experts noted that tropospheric ozone is formed in the atmosphere from precursor emissions of CH_4, NO_x and CO. Tropospheric ozone is a greenhouse gas and therefore has an effect on temperature. Tropospheric ozone is not covered by the Kyoto Protocol. Attribution to emitters of CH_4, NO_x and CO is not possible for years prior to 1990.

3. Concentrations to radiative forcing

45. The experts concluded that any attribution calculation of CO_2 and CH_4 should include the non-linearities due to the saturation of the absorption bands as described in the IPCC Third

Assessment Report (TAR). The overlap of the absorption lines of N_2O and CH_4 is much less significant but can be included as described in the IPCC TAR for completeness.

4. Radiative forcing to temperature increase

46. The experts noted that several parameterizations and models of the relationship between radiative forcing and changes in global-average surface temperature are available.

47. Regarding future work, it was recommended that the sensitivity of the attribution estimates to the different parameterizations and models of the temperature response be examined.

5. Temperature increase to sea-level rise

48. The experts noted that several parameterizations and models of the relationship between the global-average surface temperature and sea-level rise are available. Calculations should include a range of model parameters and all contributions, including those other than thermal expansion.

49. Regarding future work, it was recommended that the sensitivity of the attribution results to the different parameterizations and models of the response of the sea level to increased temperature be examined.

6. Radiative forcing to rate of change of the temperature

50. The experts concluded that the rate of temperature change is a potentially useful indicator and should be considered in calculating the attribution as the time derivative of the temperature (see paragraph 23).

7. Temperature increase to damages

51. The experts noted that the attribution of damages to sources of emissions would be different from the attribution of temperature increase to the same sources, since the damages may not be directly proportional to the increase in temperature. Damages are likely to increase faster than temperature increases. The quantification of damages is extremely difficult. Aggregated damage functions may not be calculated objectively. Damages from extreme weather events could be particularly important, but there is no readily available method to make such global estimates. Damages from catastrophic changes could increase considerably with small additional changes in the temperature, making the attribution to individual sources very difficult.

52. Regarding future work, it was recommended that the sensitivity of the attribution results to the different available damage functions be examined.

V. POSSIBLE NEXT STEPS

53. At the expert meeting, views differed on which issues should be included under "scientific and methodological aspects". While some participants thought that only the calculation method to attribute responsibility for climate change to emission sources should be included, others favoured a broader approach.

54. The previous section contains a number of recommendations relating to specific aspects of the Brazilian proposal that could be addressed in the future. Several experts indicated they are

willing to cooperate to make this happen, but this would require some financial resources. Most importantly, however, there is a need to ensure that future scientific work is designed to address the needs of the Parties.

55. Parties may wish to provide views on the following possible next steps.

(a) To initiate a research effort to develop a database of emissions and scientific parameterization and then to perform the calculations recommended by the experts;

(b) To request the secretariat to organize an expert meeting after several research groups have performed the recommended calculations, to compare the results;

(c) To establish a process for continuing the exchange of scientific and technical information on aspects of the proposal by Brazil that need further consideration, taking into account the policy needs of the Parties.

Annex

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